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WINTER CANOLA STAND ESTABLISHMENT USING THE ZIMMERMAN DEEP FURROW DRILL

Don Wysocki, Bill Schillinger, Sandy Ott and Kathy Ward

INTRODUCTION

The optimum sowing time for winter canola (*Brassica napus)* in eastern Oregon is mid-August to mid-September (Wysocki et al., 1992). The probability of a soaking rain is low during this time, so canola is usually planted on summer fallow. Hot, dry weather conditions or tilling too deep in summer fallow can cause the seed zone to be too hot and dry for seedling establishment. Ideally, canola seed should be placed as shallow as possible to get seed into moist soil with a minimum of soil cover. Shallow planting is difficult in summer fallow seedbeds because suitable moisture may be as deep as 3-6 inches.

Deep furrow, split packer wheel drills such as the John Deere HZ are usually used to seed winter canola on fallow. Winter canola seed should be placed 3/4 to 1 inch into moisture with a maximum of 2 inches of cover (Wysocki et al.., 1992). This strategy is generally successful unless seedbed moisture is marginal, weather conditions turn hot, or rains cause soil crusting before emergence. Under marginal moisture or hot conditions, germination and emergence can be poor. The soil dries too quickly for the seed to imbibe, or soil temperatures are so extreme that seedlings are "burned" or "pinched off" before emergence. Rainfall exceeding 0.3 inches after sowing can result in soil crusting that prevents emergence and necessitates reseeding. If seedbed water is marginal, planting deeper to reach better moisture conditions is an option. However, seeding deeper results in greater soil cover.

Deep furrow, split packer drills have usually been the preferred seeding implement because they move dry soil from the furrow and allow the seed to be placed into moist soil with a minimum of cover. Seed can be placed 1 inch into moist soil with a maximum of 2 inches of cover, even when adequate soil water is 4 inches deep, if these drills are adjusted and operated carefully. However, if soil conditions are too dry or tractor speed too fast it is difficult to hold a furrow. Thus, even with careful management and the best drill, stand establishment may not be possible. Unsuccessful seedings increase the risk of dryland canola production.

Recently, a new deep furrow drill has been developed by Bob and Don Zimmerman of Almira, Washington (Gaffney 1993). The Zimmerman drill (ZM) was designed to sow in dry, summer fallow seedbeds and has features that seem useful for overcoming some of the stand establishment problems in winter canola. The drill creates a deeper furrow than conventional split packer drills and moves more dry soil from the row. Row opener design is such that seed placement should be more consistent than with conventional drills.

METHODS

This study compared canola stand establishment using a John Deere HZ and the Zimmerman drill. Six drill treatments, three for each drill, were compared (Table 1). The John Deere drill was a single 8-foot drill box with 7 openers on 14-inch center. The drill was equipped with a Kincaid cone seeder. Seed was weighed in packets and dispensed to the cone to achieve a sowing rate of 9 lb/acre. Twelve-inch diameter, 15 pound, hard rubber press wheels with cast iron centers were added

Table 1. Experimental planting treatments comparing a John Deere HZ drill and the Zimmerman deep furrow drill, September 1994, Pendleton, Oregon.

Drill	Treatment	Description
John Deere HZ	HZ 1	Seed placed 1-inch into moist soil
	HZ 2	Seed placed 1-inch into moist soil, additional press wheel over row
	HZ 3	Seed placed 2-inches into moist soil
Zimmerman Drill	ZM 1	Seed placed 1-inch deep, front shank at moisture line
	ZM 2	Seed placed 1-inch deep, front shank 2-inches below moisture line
	ZM 3	Seed placed 0.5-inches deep, front shank 2-inches below moisture line.

to the drill. These press wheels, when lowered, packed over the center of the row.

The Zimmerman Drill had a 10-foot drill box with 8 openers on 15-inch center. The drill has three staggered gangs of shanks for placing fertilizer and opening the row. The shanks are followed by solid packer wheels with a smooth coulter in the center. The coulter is 2 inches larger in radius than the packer wheels. Packer wheels and coulter firm the seed row. The seed opener is behind the packer wheel/coulter. A press wheel follows the opener to pack over the row. The leading shanks can be adjusted for depth to move dry soil out of the row and to bring up moist soil from below. Each seed cup was adjusted to have 7/64 inch of flute exposed. This permitted each row to have a uniform seeding rate. At this setting, the drill seeded at 9 lb/acre.

Plots were sown on 7 September 1994 with Arabella winter canola in a randomized complete block with four replications. The soil was a Walla Walla silt loam with 1 percent slope. Plot length was 40 feet and plot width was 8 or 10 feet depending on drill width. Immediately after planting, seed zone water content was determined by collecting five, 0-3 inch soil cores located at random in the row of each plot. Cores were divided into 1-inch increments and bulked for each plot.

Soil temperature measurements were taken in the upper inch of the row on 13, 15, 20, and 23 September and 18 October 1994. Temperature was determined between 2 and 3 pm, by inserting a digital probe thermometer at 45^{o} until the tip reached 1 inch in soil depth. Temperature was recorded after a 30 second equilibration period.

Emergence was determined on subplots consisting of three consecutive rows 40-inches in length. The same rows were consistently used in each plot to avoid any difference due to openers. Emergence counts were taken daily from 17 September through 30 September; every 4 days from 30 September to 1 November and on 30 November.

Depth of seeding was determined on 13 October using an incremental depth sampler. Samples were divided into 0.4- inch increments and sieved through a 0.02-inch sieve to collect seed. Seed depth was identified as the first increment in which seed was found.

Table 2. 1-inch soil temperature, seed zone water content, seed depth and estimated water content at seed depth, September 1994, Pendleton Oregon.

Drill Treatment	1-inch soil temperature F	Seedzone water content %			Seed depth (inches)	Estimated water content at seed depth
		0-1 inch	1-2 inch	2-3 inch		
HZ 1	98.2	3.5	9.8	15.2	2.7	15.2
HZ 2	94.3	4.1	11.1	15.7	2.1	15.1
HZ 3	98.7	3.9	8.3	13.2	3.1	14.0
ZM 1	90.6	6.8	13.6	15.9	1.6	13.9
ZM 2	89.2	7.3	12.4	15.5	1.5	12.4
ZM 3	89.1	6.6	13.2	15.9	1.1	10.4

RESULTS AND DISCUSSION

Significant differences in seed zone water content, soil temperature, seed placement, and seedling emergence were observed between the drill treatments in this study. Seed zone water content is given in Table 2. Seed zone water content was highest in the Zimmerman drill treatments. The Zimmerman drill moved more dry soil out of the row and created a deeper furrow. The seed was placed deeper into the soil with respect to the original soil surface and into wetter soil. This process created a wetter seed zone in the seed row of the Zimmerman drill treatments. The highest seed zone water content in an HZ treatment was where additional packer wheels pressed over the rows (HZ 2). Packing over the row compressed the dry surface layer and lowered the surface by about half an inch. The difference in water content was due mostly to deeper sampling with respect to the original surface. Treatment HZ 3 was lowest in seed zone water. In this treatment openers were set to run deeper, and apparently more dry soil was mixed into the seed row. Water content in all treatments approached approximately 15 percent below 3 inches. This is below the depth of the moisture line set by rodweeding.

Soil temperatures at 1-inch depth are shown in Table 2. These data are the average of the five observations taken on the dates previously listed. Differences in soil temperature among drill treatments are closely related to seed zone water content. The highest 1-inch soil temperature was observed in the HZ drill treatments. Soil in these treatments was drier and less packed at the surface. Loose, dry soil has lower heat capacity and its temperature will rise higher for each unit of heat input. Treatments that were drier or that were less packed became hotter. Comparing treatments HZ 1 to HZ 2, packing over the row reduced 1-inch soil temperature by about 4^{o} F. Zimmerman drill treatments had soil temperatures that were 8-9^{o} F cooler than HZ treatments. This difference is due to a wetter environment in the seed row.

Depth of sowing is shown in Table 2. The target placement in treatments HZ 1 and HZ 2 was to put seed 1 inch into moist soil. The actual seed depth is 1 inch plus the thickness of soil that flows back into the seed

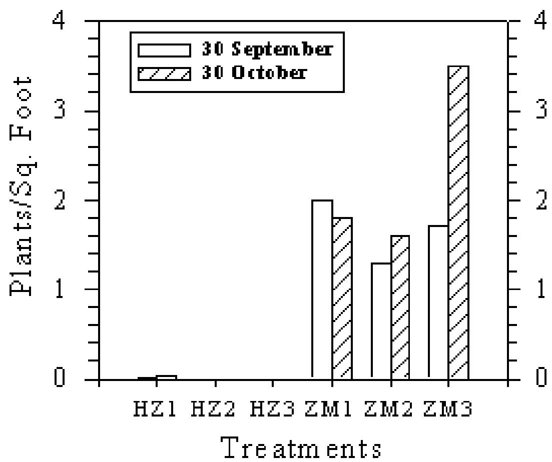

Figure 1. Canola stand on two dates in 1994 in Pendleton, Oregon.

furrow. This means that in treatment HZ 1 about 1.7 inches of dry soil was flowing back into the furrow. Dry soil cover was compressed to about 1.1 inches by using a press wheel over the row in HZ 2. There was about 1.1 inches of dry soil over moist soil in HZ 3. The difference in depth of dry soil cover between HZ 1 and HZ 3 is probably caused by mixing of moist soil in the furrow. Openers that were run 1 inch deeper in treatment HZ 3 than HZ 1 or HZ 3 brought up more moist soil from below. This changed the consistency of the soil so that less soil flowed back into the furrow over the seed.

The Zimmerman drill was adjusted for seed placement with respect to the bottom of the furrow. Seed openers and seeding depth adjusters were calibrated by placing the drill on a flat, concrete surface. The coulters within the press wheel were in contact with the concrete. This was assumed to be the bottom of the furrow. Openers were adjusted to the flat surface and then adjusted in 0.5-inch increments using a slab of metal of the correct thickness as a gauge. Depth adjusters were marked for 0-, 0.5-, 1.0-, 1.5-, and 2.0-depths. An adjuster depth setting of 1 inch meant that openers were 1 inch below the bottom of the coulter. The difference between opener depth setting and actual seed depth is attributed to soil flowing back into the row. The difference in depth setting between ZM 2 and ZM 3 was 0.4 inches (Table 1), and the corresponding difference in measured seed depth was also 0.5 inches (Table 2). This indicates that opener depth adjusters were correctly calibrated.

Seedling emergence counts on two dates are shown in Figure 1. John Deere HZ treatments had few or no plants emerge. Zimmermann drill treatments had better, but marginal, canola emergence. Weather conditions after planting were extremely hot and dry (Figure 2). Plant emergence began on 17 September. Maximum air temperatures exceeded 80^{o} F until 30 September. Seed in all treatments did hydrate and germinate. However, we observed that seedlings did not emerge or died when cotyledons were "burned off" by excessive heat at the soil surface. Seed-zone water was measured once immediately after planting. It is not known if or how quickly the seed zone dried during the emergence period. Evaporation was high over this period (Figure 2). Many germinated seeds never emerged. We speculate that these seedlings did not surface because of the combined effects of hot, dry weather, high soil temperatures, and loss of moisture in the seed zone after planting. Because conditions were more favorable in Zimmerman drill treatments (Table 2), stand performance was better. These treatments achieved stands that were marginally acceptable.

Differences in stand density were observed between 30 September and 30 October in the Zimmerman drill treatments (Figure 1). Plants were lost over this period in treatment ZM 1. This decline resulted from predation by insects and birds. Increases in

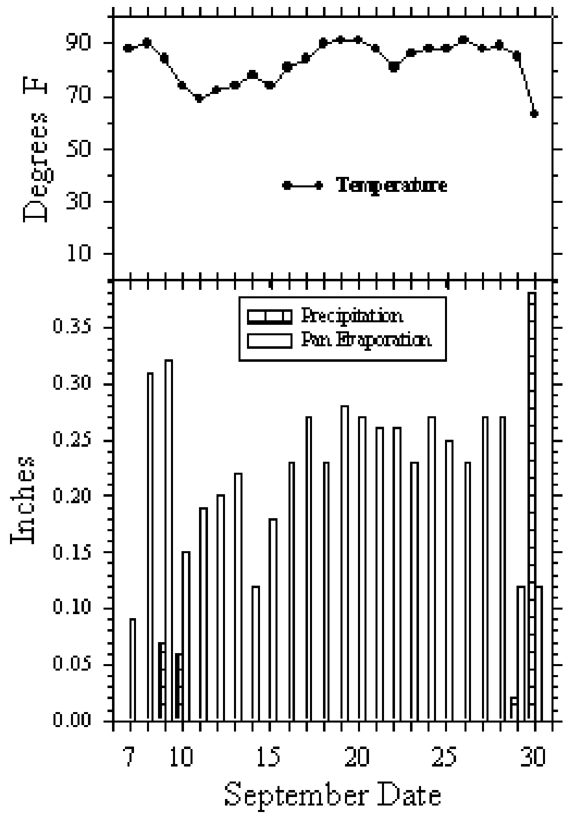

Figure 2. Maximum daily air temperature, rainfall, and pan evaporation for September, 1994, Pendleton, Oregon.

stand density were observed in treatments ZM 2 and ZM 3. This change resulted from 0.38 inches of rain on 30 September (Figure 2). The plant population nearly doubled in Treatment HZ 3. Seed was placed shallow and soil water content at seed depth was slightly over 10 percent (Table 2). This apparently was insufficient for some seed to hydrate. After rain on 30 September seed did hydrate. At that point, germination started and a flush of new seedlings were able to emerge.

CONCLUSION

We compared winter canola plantings using a John Deere HZ drill and the newly designed Zimmerman drill. Plots sown with the John Deere HZ drill had lower seed-zone water content, higher mid-day soil temperatures, and more dry soil over the row. Canola emergence was almost zero on HZ drill treatments, while plots, planted with the Zimmermann drill had stands that were slightly better, but marginal. Canola seed germinated in all plots but was unable to emerge. At the sowing rate used in this study, about 20 seeds per square foot were planted. In the best treatment (ZM 3), less than 25 percent of the seed was able to establish. Extremely hot and dry conditions during the emergence period caused seeding death before and after emergence.

The increase in stand from 30 September to 30 October in the ZM 3 treatment suggests that a shallow "dusting in" might be feasible. However, rainfall would need to be sufficient to germinate the seed and provide water to enable the roots to reach moist soil below.

We conclude from this study that the Zimmerman drill is capable of creating more favorable seed zone conditions for winter canola. This drill moves more dry soil from the furrow and consequently moist soil is closer to the surface. This is an advantage when seeding canola because the seed does not have to be planted as deep. In the exceptionally dry, hot September of 1994, the Zimmerman drill produced marginal canola stands, while the HZ drill produced none at all.

In a related study under very marginal seeding conditions on coarse silty soils at Lind, WA, winter wheat seedling emergence was best with the ZM drill compared to conventional drills (Schillinger and Donaldson, 1994). However the ZM drill pulverized surface clods and buried practically all surface residue. This suggests that the ZM drill, in its present form, may create an unacceptable wind erosion hazard in low rainfall areas and prevent growers from meeting residue requirements for participation in farm programs.

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LITERATURE CITED

Gaffney, K. New grain drill designed by Almira farmer. Wheat Life vol 10, no. 36, p. 1, 12-14. Washington Association of Wheat Growers, Ritzville, WA.

Wysocki, D. J., S. Ott, M. Stoltz, and T. G. Chastain. 1992. Variety and planting date effects on dryland canola. *In* 1992 Columbia Basin Agricultural Research, Oregon Agric. Expt. Stn. Special Report 894.

Schillinger, W.F. and E. Donaldson. 1994. Unpublished data. Ritzville, WA